

A Proposal to Resample Apartments In the Clean-Up Area Near Ground Zero

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Outline

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- **Design Implications Regarding Recontamination and Central HVAC**
- **Survey Design Proposal**
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 - **Survey domains and strata**
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Mission Statement

“Post cleaning verification sampling in the residential areas included in EPA’s Indoor Air Cleanup to verify re-contamination has not occurred from central heating and air conditioning systems”

(Connaughton CEQ letter of 10/27/03)

Design Implications - Recontamination

- **Apartments were contaminated, then cleaned, then may have become recontaminated**
- **The population to be studied comprises the 4,167 apartments in the clean-up zone near Ground Zero that were sampled in the previous study**
- **The full population of 23,000+ apartments in the clean-up zone is not to be studied because data are not available on the previous contamination status of all the apartments**
- **The same asbestos test method will be used in order to compare the results from this survey with results from the original Clean-Up.**

Design Implications - Recontamination

Definition of “contamination”:

An apartment that has a measurement of asbestos above the Region 2 health-based benchmark level of 0.0009 fibers/cubic centimeter is contaminated

Contamination status:

- ~3400 of 4167 apartments “cleaned and tested”, 1% contaminated after cleaning;
- ~800 of 4167 apartments “tested only”, 1% contaminated;
- Of 44 contaminated apartments, 33 were recleaned, retested and were cleared upon retesting; 11 refused recleaning;
- Of 91 apartments with “overloads”, 50 were recleaned, retested and were cleared upon retesting; 41 refused recleaning

Design Implications – Central HVAC

- **Identified as a potential source of recontamination.**
- **Other possible sources include re-entrainment of within apartment contamination not removed by original cleaning, tracking in from the outside, or other means**
- **The survey can generate results that will support estimation of the rates of contamination for sub-populations of apartments regardless of the source**
- **Apartments with central HVAC or partial HVAC systems will be a primary sub-population considered in the design of the survey**

Design Implications – Central HVAC

Counts of 4,167 of apartments in the sampling universe:

- **472 in buildings with central HVACs; 430 of these in one building**
- **2396 in “partial central HVAC” – common areas are served by a central unit, but no shared air between apartments, only exhaust fans to the outside within individual apartments**
- **24 in buildings known not to have central HVAC**
- **1275 in buildings with “unknown” HVAC status**

DESIGN PROPOSAL

Mission Statement:

Post cleaning verification sampling in the residential areas included in EPA's Indoor Air Cleanup to verify re-contamination has not occurred from central heating and air conditioning systems

Objective: Design a Sample Survey

- To estimate the current asbestos exceedance rate for the 4,167 apartments that participated in the World Trade Center Residential Cleanup Program; and
- To estimate the current asbestos exceedance rate for the subset of apartments that have the potential to become re-contaminated by shared air systems.
 - The exceedance rate is the percent of apartments with an asbestos measurement exceeding the health criterion

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Survey Domains - Definition:

- A “domain” is a clearly defined subpopulation of individual units for which separate sample estimates are required. Domain specific sample estimates can be extrapolated to all members of the domain with a quantifiable level of precision.

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Domains for this survey:

1. The full population of **4167 apartments**
2. Apartments served by a central HVAC (472 apts) + apartments in buildings with partial HVAC systems (2396 apts; common areas served by HVACs; no shared air between apartments with only outside venting in individual apartments) **2868+ apartments**

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Population Strata - Definition:

- Strata are clearly defined and distinct subsets of individual units within a population to be sampled. Strata are used to facilitate the sample design and improve the precision of survey estimates.
- Unlike domains, achieving strata estimates with certain levels of precision is not a primary factor in determining the sample design.

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Assignment of Apartments to Different Strata:

- 1. “Cleaned and tested” versus “tested only”**
- 2. “Modified aggressive sampling” versus “aggressive sampling”**
- 3. Different findings for asbestos:**
 - Non-detect**
 - Detected at or below benchmark**
 - Above benchmark**
 - No asbestos result; overloaded filter**

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Domain 1 – Counts of all 4167 apartments by clean/test status & sampling method:

	<u>Modified Aggressive</u>	<u>Aggressive</u>
Clean and Test		
Non-detect	2870	201
Detect	194	20
Exceed	20	15
Overload	62	4
Test only		
Non-detect	677	31
Detect	39	0
Exceed	8	1
Overload	23	2
Totals	3893	274

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**Domain 2 – Counts of Central HVAC + Partial Central HVAC =
2868 apartments by Clean/Test Status & Sampling Method:**

	<u>Modified Aggressive</u>	<u>Aggressive</u>
Clean and Test		
Non-detect	2011	183
Detect	135	15
Exceed	15	10
Overload	38	4
Test only		
Non-detect	394	29
Detect	21	0
Exceed	2	1
Overload	9	1
Totals	2625	243

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Issues for sample size determination:

- **Resource constraints**
- **Total cost of sampling and analysis**
- **Allocation of samples to population domains/strata**
 - **For example, the HVAC domain may be “oversampled”**
- **100% sampling rate for “exceedance” stratum and “overload” stratum**
- **Desired precision for sample estimates**

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Issues for sample size determination:

- **No concurrent sampling of “background” apartments is planned for reasons of cost, time, and expected enlistment difficulty.**
- **In addition to a sample of the 4167 apartments from original study, add all apartments at 110 Liberty, 114 Liberty, and 125 Liberty. These will be outside sampling frame but will be of interest for comparison with original results from these locations.**

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Sampling Basics and Sample Size Decisions

N = number in the population, 4167 apts.

**P = proportion of the population above
the standard**

n = number in the sample ($< N$)

**k = number in the sample above the
standard ($\leq n$)**

Sample data are used to estimate P and NP

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Sampling Basics and Sample Size Decisions

To estimate P , the proportion of apartments in the population above the standard, use the estimator (with no oversampling) of P

$$p = k / n.$$

A key factor in the evaluation of alternative sample size options is the precision of the estimator, a measure of the error in using p to estimate P .

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Precision – Key Concept for Evaluating Sample Size Decisions:

- In general, the larger the sample size the greater the precision of the estimate, i.e., the smaller the likely error in the estimate
- The width of the confidence interval for P is a measure of precision
- The shorter the confidence interval, the greater the precision

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Confidence Interval for P :

Based on sample results, we say that P lies within two values, a lower confidence limit (LCL) and an upper confidence limit (UCL) with a high degree of statistical confidence (generally 95% confidence). That is,

$$**LCL < P < UCL**$$

Statistical methods are used to calculate LCL and UCL based on the estimator for P , the sample size and the sample design.

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The chosen sample design should provide the specified survey estimates with adequate precision at minimum cost.

The sample size must be manageable within the cost and resource constraints.

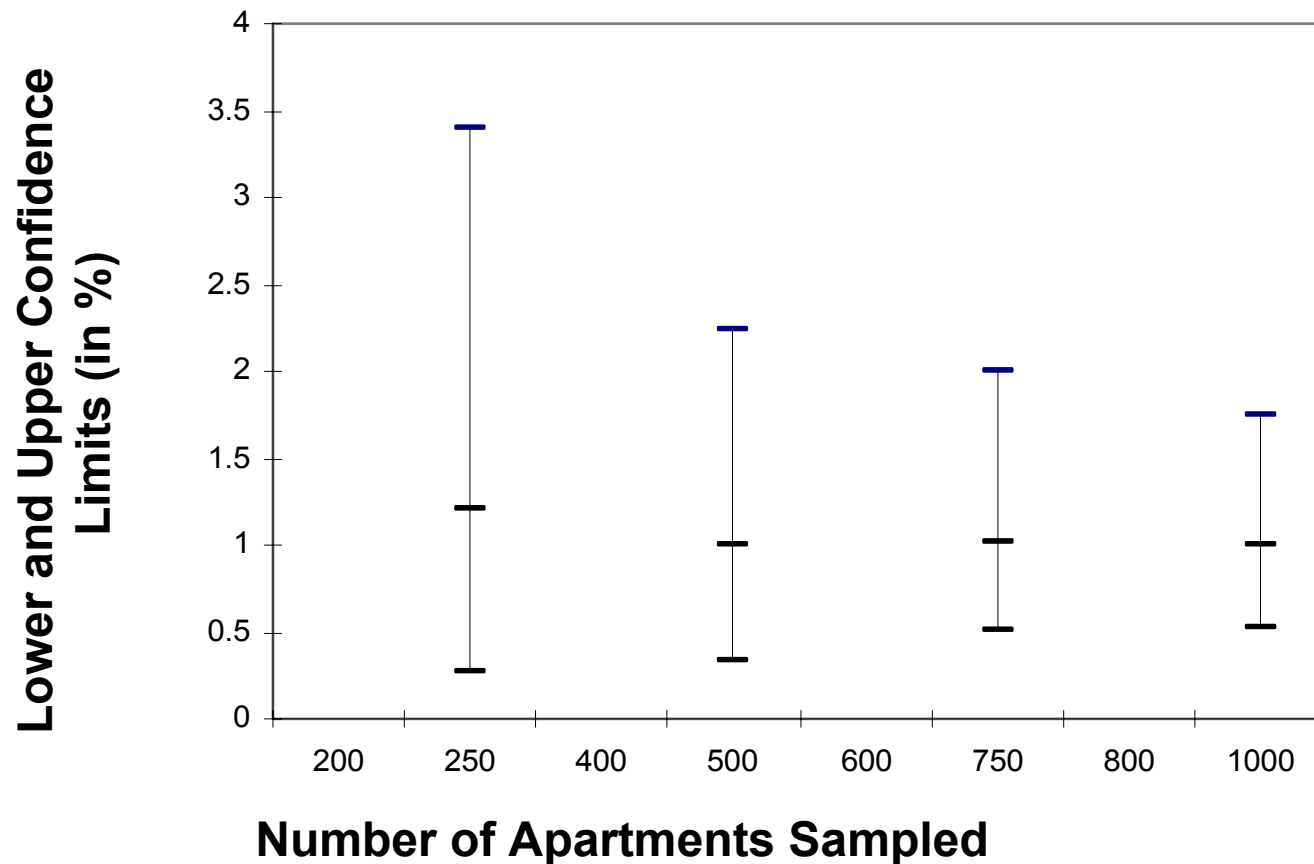
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Example 1: Confidence Intervals for number exceeding the standard in a population of 4167 assuming that around 1% of the sample exceed

Sample Size (n)	Number Exceeding (k)	Estimate (k/n)	95% Confidence Limits (% of Total)		95% Confidence Limits (# out of 4167)	
			Lower Limit	Upper Limit	Lower Limit	Upper Limit
250	3	1.20%	0.27%	3.40%	11	142
500	5	1.00	0.34	2.24	14	93
750	8	1.07	0.42	1.82	18	76
1000	10	1.00	0.53	1.74	22	73

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Upper and Lower 95% Confidence Limits for P(%) in 4167 Apartments vs. Number Sampled: 1% Sample Incidence



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Example 2: Confidence Intervals for number exceeding the standard in a population of 4167 assuming that around 3% of the sample exceed

Sample Size (n)	Number Exceeding (k)	Estimate (k/n)	95% Confidence Limits (% of Total)		95% Confidence Limits (# out of 4167)	
			Lower Limit	Upper Limit	Lower Limit	Upper Limit
250	7	2.8%	1.18%	5.61%	49	234
500	15	3.00	1.75	4.77	73	199
750	22	2.93	1.94	4.28	81	178
1000	30	3.00	2.15	4.11	90	171

ANOTHER DESIGN DECISION

Should the apartments in the HVAC domain be oversampled? Oversampling:

- **Increases the precision of estimates for the HVAC domain**
- **Decreases the precision of estimates for the full population domain**

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Post-Survey Data Analysis:

- **Statistically-based rate of contamination comparisons in the primary survey domains**
- **Other statistically-based comparisons to original survey:**
 - **Short fiber results**
 - **Overall frequency of detection, not only rate of contamination**
 - **Apartment-by-apartment paired tests**
- **Discussion of current results compared to “background”**